

REMARKS

This application has been revised and the following remarks are submitted in light of the Office Action mailed November 3, 2004. Claims 15-34 are presented for examination. Claims 15 and 26 have been amended, and Claim 34 has been added.

The claim amendments and new claim presented herein are fully supported by the specification as originally filed. Amended Claim 15 and new Claim 34 are supported by the specification at page 16, lines 13-16. Claim 26 has been amended to correct a typographical error. No new matter has been added.

Objection to Claim 26

Claim 26 is objected to because, in lines 2-3, "a conductive material" should be changed to "the conductive material" for clarity. This claim has been amended in accord with this suggestion. Applicants therefore submit that this objection to Claim 26 has been overcome.

Rejection of Claims 15-20, 26-28 and 30-33 under 35 U.S.C. 103(a) over Ngo et al. in view of Gabriel et al.

Claims 15-20, 26-28 and 30-33 are rejected under 35 U.S.C. 103(a) over U.S. Patent No. 6,727,176 to Ngo et al. in view of U.S. Patent No. 6,475,929 to Gabriel et al. Applicants respectfully traverse this rejection.

Claim 15, as amended, is directed to a method for forming an interconnect structure on a substrate. After a dielectric layer and hardmask are deposited, an opening is formed, and a conductor is then formed by filling the opening with a conductive material. This method further comprises the step of exposing the conductor to a reducing plasma comprising at least one gas selected from the group consisting of H₂, N₂, NH₃ and noble gases. It is a feature of the present invention that a pre-clean layer is formed as result of this exposing step, the pre-clean layer comprising copper, silicon and oxygen. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Ngo et al. in view of Gabriel et al., as follows.

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The Ngo et al. patent is directed to a method of forming reliable Cu interconnects. The method of Ngo et al. includes the step of treating the exposed Cu surface in a plasma containing NH_3 (col. 4, lines 50-52). Ngo et al., however, fail to disclose the formation of a pre-clean layer comprising copper, silicon and oxygen.

Ngo et al. not only fail to disclose, but also fail to suggest the formation of such pre-clean layer. Ngo et al. teach that the exposed Cu surface should be treated with a plasma containing NH_3 "to remove copper oxide therefrom" (col. 4, line 52). Thus, Ngo et al. not only fail to suggest, but actually teach away from, the formation of a pre-clean layer comprising copper and oxygen.

Gabriel et al. fail to remedy the deficiencies of the Ngo et al. patent in this regard. The Gabriel et al. patent is directed to a method of manufacturing a low-k semiconductor structure. The method includes the steps of forming a low-k dielectric layer, forming a sacrificial etch stop layer adjacent the low-k dielectric layer, and applying energy to the sacrificial etch stop layer to effect diffusion of a component from the sacrificial layer into the low-k dielectric layer. Gabriel et al. fail to disclose or even suggest the formation of a pre-clean layer comprising copper, silicon and oxygen, and therefore fail to provide any motivation to modify the teaching of Ngo et al. in this regard.

Accordingly, Applicants respectfully submit that Claim 15 is patentable over Ngo et al. in view of Gabriel et al. Claims 16-20, 26-28 and 30-33, which depend from Claim 15, are also patentable over Ngo et al. in view of Gabriel et al. Applicants therefore request withdrawal of this rejection.

Rejection of Claims 15-33 under 35 U.S.C. 103(a) over Ngo et al. in view of Kudo

Claims 15-33 are rejected under 35 U.S.C. 103(a) over Ngo et al. in view of U.S. Patent No. 6,420,261 to Kudo. Applicants respectfully traverse this rejection.

It is a feature of the method of Claim 15 that a pre-clean layer is formed, the pre-clean layer comprising copper, silicon and oxygen. Applicants respectfully submit that this feature (at least) is neither disclosed nor suggested by Ngo et al. in view of Kudo, as follows.

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As discussed previously, Ngo et al. not only fail to disclose, but also fail to suggest the formation of such pre-clean layer. Ngo et al. teach that the exposed Cu surface should be treated with a plasma containing NH_3 "to remove copper oxide therefrom" (col. 4, line 52). Thus, Ngo et al. not only fail to suggest, but actually teach away from, the formation of a pre-clean layer comprising copper and oxygen.

Kudo fails to remedy the deficiencies of the Ngo et al. patent in this regard. The Kudo patent is directed to a dual damascene method of manufacturing a semiconductor device. In this method, Kudo fails to disclose or even suggest the formation of a pre-clean layer comprising copper, silicon and oxygen, and therefore fails to provide any motivation to modify the teaching of Ngo et al. in this regard.

Accordingly, Applicants respectfully submit that Claim 15 is patentable over Ngo et al. in view of Kudo. Claims 16-33, which depend from Claim 15, are also patentable over Ngo et al. in view of Kudo. Applicants therefore request withdrawal of this rejection.

Conclusion

Applicants have properly traversed each of the grounds for rejection in the Office Action, and therefore submit that the present application is now in condition for allowance. If the Examiner has any questions or believes further discussion will aid examination and advance prosecution of the application, a telephone call to the undersigned is invited.

No fee is believed to be due for the submission of this amendment. If any fees are required, however, the Commissioner is authorized to charge such fees to Deposit Account No. 09-0458.

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Respectfully Submitted,



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